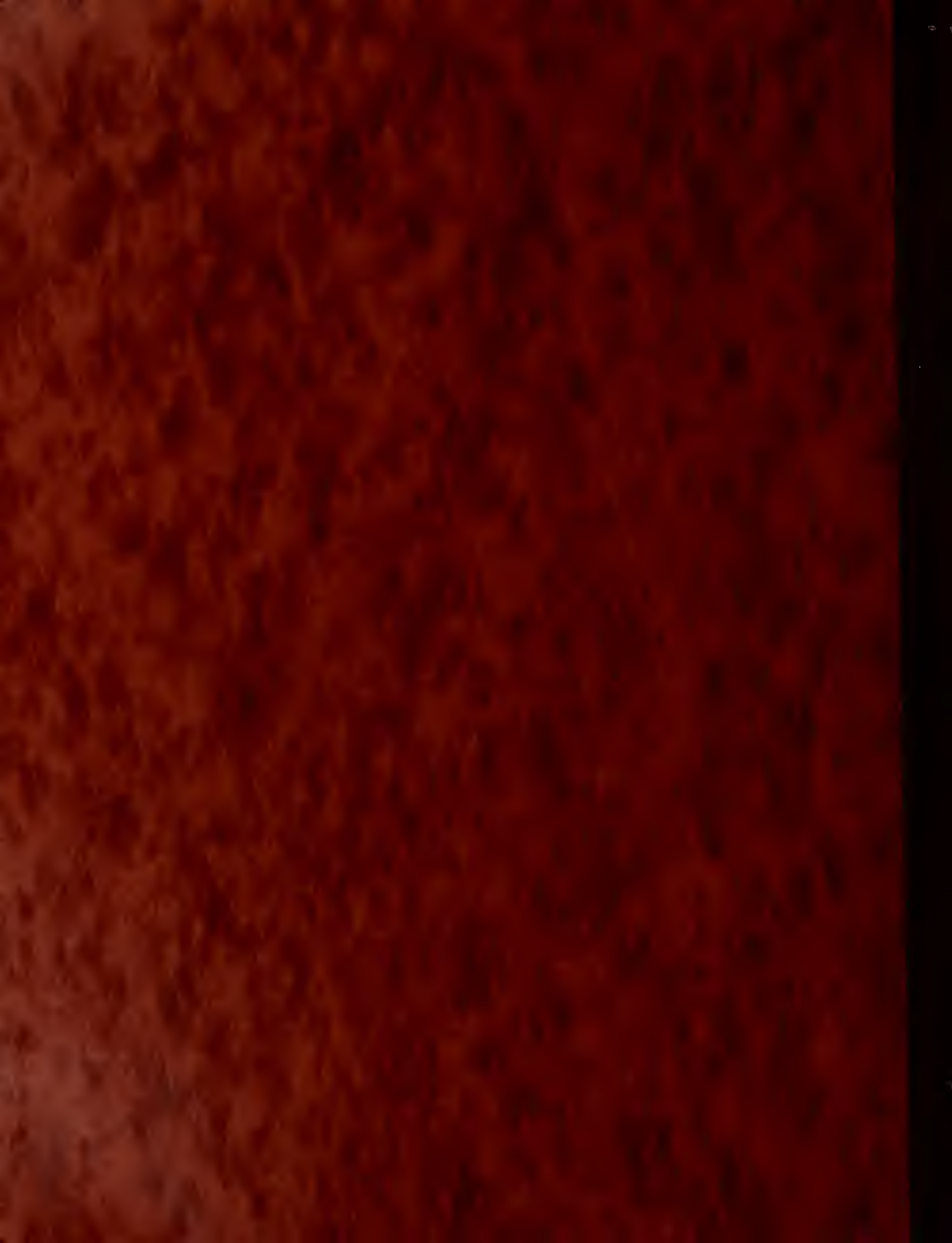


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Updated Forecasts of the Costs of Medical Care for Persons with AIDS, 1989-93

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The Agency for Health Care Policy and Research (AHCPR) was established December 19, 1989 by section 6103 of Public Law (P.L.) 101-239, the Omnibus Budget Reconciliation Act of 1989. The new agency replaces the National Center for Health Services Research and Health Care Technology Assessment (NCHSR) within the Public Health Service (PHS).

Updated Forecasts of the Costs of Medical Care for Persons with AIDS, 1989–93

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Synopsis

Data on the number of AIDS cases reported to the Centers for Disease Control (CDC) from January 1984 to June 1989 are used to predict the number of AIDS cases that will be diagnosed during the years 1989 through 1993. Using quad-

ratric and linear models with the most recent data, it is projected that about 44,000 cases will be diagnosed in 1989, 56,000 in 1990, 70,000 in 1991, 87,000 in 1992, and 104,000 in 1993. These projections are lower than estimates derived using data from January 1984 to June 1988, and they are similar to estimates derived by the CDC.

The lifetime medical care cost of treating a person with AIDS is estimated to be about \$75,000 (all estimates are in 1988 dollars) assuming that the average length of survival is 15 months and that the intensity of care (that is, the cost of medical care per month) does not fall as longevity rises. This total, \$75,000, reflects recent increases in the length of survival and the diffusion of costly drug therapies (for example, AZT and aerosol pentamidine). This study forecasts that the cumulative lifetime medical care costs of treating all people diagnosed with AIDS during a given year to be about \$3.3 billion in 1989, \$4.3 billion in 1990, \$5.3 billion in 1991, \$6.5 billion in 1992, and \$7.8 billion in 1993.

ESTIMATES ARE PRESENTED for the cumulative lifetime medical care costs of patients diagnosed with AIDS during the years 1989 through 1993. These estimates are a product of the number of people who will acquire AIDS during a given year and the average lifetime cost of treating each person. Medical care costs include hospital, nursing home, home health, counseling, and drug costs. Education, testing, and research costs, as well as costs associated with the implementation of the universal precautions, are excluded. In addition, the value of lost productivity due to increased mortality and morbidity is not considered. The cost of treating HIV-infected people without AIDS is not within the scope of this paper but is discussed briefly in the final section. In particular, the cost implications of recent recommendations regarding the prophylactic use of aerosol pentamidine and AZT (Retrovir) are considered.

Estimates of the number of people who will acquire AIDS from 1989 through 1993 are derived using data on the number of AIDS cases reported to the Centers for Disease Control (CDC) from January 1984 to June 1989. These are lower than

previous estimates derived using data on AIDS cases reported from January 1984 to June 1988 because the rate of increase in the reported cases dropped during the second half of 1988 and the first half of 1989 (1). There were 10 percent more cases (16,911) reported during the first half of 1989 than during the second half of 1988 (15,569), and there were only 2 percent more cases reported during the second half of 1988 than the 15,278 reported during the first half of 1988 (2–4). In comparison, there were 30 percent more cases reported during the second half of 1987 than during the first half of 1987, and 32 percent more cases reported during the second half of 1986 than during the first half of 1986 (1,5).

The next section of this paper briefly examines the impact of the revised definition of AIDS on case reporting, changes in the proportion of cases in various exposure categories, and the lengthened survival of persons with AIDS (PWAs). The medical care costs of treating a PWA are estimated in the third section. The fourth section forecasts the number of people who will acquire AIDS during the years 1989 through 1993. The last section forecasts the cumulative costs of treatment for

'After the revised definition was issued on September 1, 1987, there was a surge in the number of reported AIDS cases. There was a 79 percent increase in the number of AIDS cases reported to the CDC for the period September 1987 to May 1988 compared with the number reported for a similar 36-week period from December 1986 to September 1987.'

people diagnosed with AIDS for the years 1989 through 1993 and presents some final remarks.

Recent Trends

The surge and subsequent moderation of reported AIDS cases. On September 1, 1987, CDC implemented a revised definition of AIDS that included dementia, wasting syndrome, and cases diagnosed presumptively (that is, without conformation by methods as required by the old definition) for people who have positive test results for human immunodeficiency virus (HIV) (6). The development of tests to detect the presence of antibodies to HIV made it feasible to diagnose AIDS in people who tested positive for HIV and manifested some clear signs of opportunistic infections or Kaposi's sarcoma. For example, a person who tests positive for HIV fits the revised definition of AIDS if plaque-like lesions on the skin or mucous membrane indicative of Kaposi's sarcoma are found (presumptive diagnosis). Before the revised definition was adopted, a definitive diagnosis of Kaposi's sarcoma required that a microscopic examination be performed. *Pneumocystis carinii* pneumonia (PCP) may be diagnosed presumptively from a chest X-ray or arterial blood gas analysis, or both, for people who test positive for the HIV. A definitive diagnosis of PCP requires that procedures such as bronchoscopy or lung biopsy be performed to obtain a tissue sample.

After the revised definition was issued on September 1, 1987, there was a surge in the number of reported AIDS cases. There was a 79 percent increase in the number of AIDS cases reported to the CDC for the period September 1987 to May 1988 compared with the number reported for similar 36-week period from December 1986 to

September 1987. Yet the number of cases reported dropped 3 percent for the period from May 1988 to February 1989 compared with the period between September 1987 and May 1988 (7,8).

One explanation for this surge in cases reported after September 1987 is that local health departments kept records of sizable numbers of cases that met the revised definition before the revised definition was implemented. An analysis of the cases reported to CDC after September 1, 1987, and before October 1988 indicates that cases meeting the pre-1987 definition were reported within a shorter period than cases meeting only the 1987 definition (table 1) (9). However, the difference in the lag from the time of diagnosis to the time of reporting between these groups is relatively small, suggesting that the surge was not due solely to the reporting of cases by local health departments that had been diagnosed many months or years before the definition was changed.

The surge in the number of cases reported following the implementation may have been a one-time occurrence, and the number of reported cases will eventually approach the number of AIDS cases that would have been reported under the pre-1987 definition of AIDS. This is true if most of the cases that meet the revised definition eventually meet the pre-1987 criteria (that is, people who have dementia or wasting syndrome eventually acquire manifestations included in the pre-1987 definition, such as PCP, Kaposi's sarcoma, and if patients diagnosed presumptively would eventually have been diagnosed definitively). Yet, there are no published data on the percentage of people with dementia and wasting syndrome who eventually acquire a manifestation of AIDS that was included in the pre-1987 definition. In addition, there is no method of determining how many AIDS cases that now are diagnosed presumptively would eventually have been diagnosed definitively.

Changes in exposure categories. It has been hypothesized that the increase in the proportion of AIDS patients categorized as intravenous drug users (IVDUs) is partly a result of better reporting of IVDUs under the revised definition. Altman recently stated (10):

Heterosexual users of intravenous drugs accounted for 23 percent of the new cases reported in the country in 1988, up from the figure of 17 to 18 percent that had been steadily reported since 1982. Federal health officials attribute part of the rise to improved

reporting of cases resulting from a change in definition of an AIDS case. But they also say there has been a real rise in the number.

There is evidence that improved reporting of IVDUs under the revised definition, presumably as a result of the presumptive diagnosis of IVDUs, has contributed to the increased proportion of IVDU cases. A total of 24,721 AIDS cases were diagnosed and reported to CDC between September 1, 1987, and November 4, 1988. Of the 17,962 cases that met the old definition, 18 percent of the patients were categorized as IVDU and 63 percent were categorized as homosexual-bisexual (personal communication from John Karon, PhD, Statistics and Data Management Branch, AIDS Program, CDC). (Note that the 1987 revision expanded the definition of AIDS, and a case that fits the pre-1987 definition automatically fits the 1987 definition.) Of the 6,759 cases that met only the revised definition, 35 percent of the patients were categorized as IVDU, and 43 percent as homosexual or bisexual. Thus, the proportions of IVDUs and homosexual or bisexual men with cases that met the old definition were almost the same as those reported before the revised definition was adopted. This observation indicates that the increase in the proportion of persons with AIDS categorized as IVDUs after September 1, 1987, is attributable to the high proportion of IVDUs with cases that only meet the revised definition.

Length of survival. The average length of survival of an AIDS patient following diagnosis has risen steadily over the past few years (11). Rothenberg and coworkers used data through 1985 on 5,900 AIDS cases in New York City and found that the average AIDS patient lived about 1 year after diagnosis (12). More recent data from New York State show that 34.8 percent of homosexual and bisexual AIDS patients diagnosed in 1985 lived 18 months, but 62.9 percent of homosexual and bisexual AIDS patients diagnosed in 1987 lived 18 months (13). The corresponding proportions of IVDU AIDS patients surviving were 26 percent in 1985 and 50 percent in 1987. These statistics imply that more than half of the PWAs diagnosed during 1987 in New York State will live 18 months.

Kizer and coworkers projected the mean survival time of a Medi-Cal AIDS patient currently alive to be 17.87 months and the median survival time as 13.1 months (14). Data on 4,371 AIDS cases reported to the San Francisco Department of Health indicate that the median survival of an

Table 1. Cumulative proportion of cases reported to the Centers for Disease Control (CDC) between Sept. 1, 1987, and Oct. 3, 1988, reported within X months from date of diagnosis

| X months | Cases meeting pre-1987 definition | Cases meeting only the 1987 definition |
|----------|-----------------------------------|----------------------------------------|
| 0 | .0358 | .0309 |
| 1 | .2841 | .2165 |
| 2 | .5117 | .3883 |
| 3 | .6339 | .5004 |
| 4 | .6986 | .5723 |
| 5 | .7440 | .6211 |
| 6 | .7757 | .6598 |
| 7 | .8007 | .6889 |
| 8 | .8202 | .7178 |
| 9 | .8379 | .7377 |
| 10 | .8547 | .7611 |
| 11 | .8678 | .7804 |
| 12 | .8802 | .7971 |

SOURCE: CDC Public Information Data Set.

AIDS patient has risen from 10.2 months for patients diagnosed in 1981 to 14.4 months for patients diagnosed in 1986 (15). Assuming that the relationship between the mean and median is stable, this implies that the mean survival time of PWAs in San Francisco is 19.64 months $((14.4) \times (17.87 \div 13.1))$.

The San Francisco Department of Health forecasts that the median time of survival will increase from 14.4 months in 1988 to 22 months in 1993 (15a). If it is assumed that the relationship of the mean to median survival times remains at 1.36 $(17.87 \div 13.1)$, then the 22-month estimate for the median survival time in 1993 translates to an estimate of about 30 months for the mean survival time in 1993.

In calculating the total cost of treating PWAs, the mean survival time is more important than the median. To calculate cumulative costs, the average months of survival (the mean) and the number of PWAs are multiplied. It is not necessary to know the number of months of survival at which one-half of the PWAs live longer and one-half live shorter (the median) in order to calculate the total cost of treating PWAs.

Average Lifetime Cost of Treatment

In this section, the average lifetime cost of treating a PWA in 1988 is estimated. This estimate is obtained by combining estimates of the length of a hospital stay, the charge per hospital day, the annualized number of hospitalizations per patient, the cost of outpatient care, outpatient drug costs,

Table 2. Estimated lifetime medical care costs of treating an AIDS patient (1988 dollars)

| Components of care | Average survival times | | |
|--------------------------------------------|------------------------|-----------|-----------|
| | 12 months | 15 months | 18 months |
| Inpatient..... | \$47,489 | \$59,362 | \$71,234 |
| Outpatient..... | 8,381 | 10,476 | 12,571 |
| Out-of-pocket: | | | |
| AZT..... | 1,800 | 2,250 | 2,700 |
| Aerosol pentamidine..... | 735 | 919 | 1,102 |
| AL-721..... | 257 | 322 | 385 |
| Dextran sulfate..... | 144 | 180 | 216 |
| Other drugs and alternative therapies..... | 1,200 | 1,500 | 1,800 |
| Total..... | \$60,006 | \$75,009 | \$90,008 |

and the cost of unapproved therapies. Cost in this study refers to the cost of care to the purchaser—not the cost of producing the health care services.

Table 2 presents estimates of the lifetime medical care costs of treating an AIDS patient in 1988 dollars. The best estimate of the lifetime medical care cost of treating a PWA is \$75,009. This estimate assumes that the average survival is 15 months and that the intensity of care (that is, treatment cost per month) is the same throughout this period. Since most of these costs were derived using data from PWAs diagnosed a year or two ago, they reflect the cost of care of persons whose average lifespan was about 1 year. The calculations for lifetime costs for longer lifespans assume that the intensity of care is constant throughout the lifetime of an AIDS patient. If the intensity of care decreases as longevity increases, then the estimates for the cost of the 15-month and 18-month survival times in table 2 are biased upward.

Average length of a hospital stay. A study completed by the Commission on Professional and Hospital Activities (CPHA) used individual discharge records from 1,228 hospitals representing 21.5 percent of short-term general hospitals in the United States for 1987. The average length of stay for an AIDS patient was 14.9 days (16). Of more than 6 million discharge records submitted by the hospitals in the CPHA sample, 11,477 admissions had an AIDS code; 27.4 percent had AIDS coded as the principal diagnosis, and 72.6 percent as a secondary diagnosis.

A survey sponsored by the National Public Health and Hospital Institute (NPHHI) and reported by Andrulis and coworkers found the average length of stay from 276 hospitals was 16.8 days in 1987 (17). The survey questionnaire was sent to

623 hospitals that were members of the National Association of Public Hospitals, Council of Teaching Hospitals of the Association of American Medical Colleges, National Association of Children's Hospitals and Related Institutions, and National Council of Community Hospitals. To the extent possible, the hospitals used the definition in effect when the patient was hospitalized to identify AIDS patients. An average of the hospital stays from the CPHA and NPHHI surveys, 15.85 days $((14.9 + 16.8) \div 2)$, is used as the estimated average hospital stay for an AIDS patient in this study.

Hospital charges per day. The amount used in this study for the average hospital charge for a patient with AIDS is \$1,000 per day. It is derived from two sources. Data from all 148 hospitals that provided charge data in the NPHHI survey indicate that the average was \$864 per day for care of an AIDS patient (17). The second source was a study of all persons with AIDS known to be enrolled in Medi-Cal that was conducted by the California Department of Health Services (14). Medi-Cal patients with AIDS were identified by assembling a list of all beneficiaries with AIDS-related ICD codes recorded on a paid claim. To eliminate cases that were miscoded, this list was matched by SOUND-EX code (a four-character code based on the patient's name, date of birth, sex, county of residence, and date of death if deceased) with data from the Office of AIDS Reporting System of the State of California. Using this methodology, 3,397 cases were identified. Data from the Medi-Cal claims file indicated that the average Medi-Cal hospital payment per day for the year April 1, 1987, through March 31, 1988, was \$622. Since Medi-Cal reimbursed for only 56.3 percent of charges in fiscal year 1987-88, this implies that the average hospital charge per day was \$1,105 during fiscal year 1987-88.

Annualized number of hospitalizations per patient. The annualized number of hospitalizations per patient is the average number of times a patient is hospitalized during 12 months. It is equal to the average number of hospital admissions for a patient who is alive for any part of a year divided by the fraction of a year lived by the average patient. In a 1985 survey of 169 hospitals, Andrulis and colleagues found that the average number of hospitalizations for a person alive during any part of 1985 was 1.6 (18), and the number remained at 1.6 in their 1987 survey (17). Both numbers reflect the

experience of all patients in the survey and are obtained by dividing the total number of hospitalizations for all patients by the total number of patients.

These numbers are consistent with those reported by Seage and coworkers and Scitovsky and Rice (19,20). Seage and coworkers evaluated the use of health services by 45 AIDS patients in Massachusetts and showed that the average number of hospitalizations for a patient alive during any part of 1984 was 1.6. Scitovsky and Rice used an estimate of 1.7 for the average number of hospitalizations for a patient alive during any part of a year (20). Their estimate was based on data from San Francisco General Hospital (SFGH) adjusted to reflect the distribution of cases by diagnostic groups (PCP, Kaposi's sarcoma, and all other conditions) in the United States. In this study, it is assumed that the average number of hospital admissions per AIDS patient alive during the year is 1.6.

Information from San Francisco General Hospital indicates that an AIDS patient alive during 1984 lived an average of 6.5 months (21,22). Only 17.4 percent of the AIDS patients at SFGH were alive all of 1984. As survival lengthens, the percentage of AIDS patients alive during all of a year will increase, and the average number of months lived by an AIDS patient alive during any part of the year also will increase. The median survival of AIDS patients diagnosed in San Francisco was 10.8 months in 1984 (15b). This figure rose to 14.4 months in 1986.

To account for the increase in survival times observed over the past few years, it is assumed that the average number of months lived by an AIDS patient alive during any part of a year is 7 months. (Note, if the number of people who acquire a disease is constant over time and the average length of survival is 18 months, then the average number of months lived by a person with the disease during a given year is about 7 months.) Consequently, it is estimated that the annualized number of hospitalizations per year is 2.74 ($1.6 \div 7/12$).

Cost of inpatient care. An estimate of \$43,429 for the annualized inpatient care costs of treating an AIDS patient in 1987 dollars is derived using estimates of 15.85 days for the average length of stay, \$1,000 for the average hospital charge per day, and 2.74 for the annualized number of hospitalizations per patient. If it is assumed that a person diagnosed with AIDS in 1989 will live an average of 15 months, then the lifetime costs of inpatient care

will be \$54,286 in 1987 dollars, or \$59,362 in 1988 dollars (23).

Cost of outpatient care. The proportion of medical costs attributed to outpatient care provided to AIDS patients has increased over the past few years. In California, Kizer and colleagues found that 25 percent of the payments for care to AIDS patients were for outpatient services during the period from April 1, 1987, through March 31, 1988 (14). This proportion is up from 17.5 percent in fiscal year 1986-87 and 13.6 percent in fiscal year 1985-86. From 30 to 35 percent of the payments for medical care for 150 patients not treated at a public hospital in the San Francisco area were for services provided in an outpatient setting (data from Anne A. Scitovsky, MA, Chief, Department of Health Economics, Palo Alto Medical Foundation, Palo Alto, CA, May 18, 1989). A study of AIDS patients enrolled in Medicaid in Michigan between 1984 and 1987 showed that 25 percent of the payments were for outpatient care (information provided by David Solomon, PhD, Office of Medical Education, Research, and Development, Michigan State University, August 1988). Seage and coworkers found that payments for care provided on an outpatient basis represented only 5.5 percent of all payments for 241 AIDS patients in Massachusetts between March 1984 and February 1986. Data from the New York State Department of Health indicate that outpatient costs accounted for 12 percent of medical treatment expenditures in 1988 (13a).

In this study, it is assumed that outpatient care represents 15 percent of the total cost of care provided to AIDS patients exclusive of the costs of outpatient drugs and alternative therapies. This implies that lifetime outpatient costs for AIDS patients amount to \$10,476 ($59,362 \times (15 \div 85)$) in 1988 dollars, assuming an average survival of 15 months. Drugs and alternative therapies for outpatients were excluded from this estimate because care costs cited in this section were obtained from insurance records, and many people either do not have health insurance or have health insurance plans that do not cover drugs for outpatients. In addition, much of these data were obtained before AZT became generally available, and aerosol pentamidine became a common therapy.

Cost of outpatient drugs and alternative therapies. Drugs not approved by the Food and Drug Administration (FDA) for treatment of AIDS (for example, ribavirin, AL-721, dextran sulfate, ddI, fluco-

nazole, and Foscarnet) generally are not covered by health insurers, and the cost of alternative therapies (for example, mega-vitamins, acupuncture, image therapy) are rarely covered by health insurers (24). Consequently, PWAs pay for most outpatient drugs whether or not they are approved by the FDA. The Health Care Financing Administration estimates that Medicaid and private insurers pay less than 20 percent of the cost of outpatient drugs (25). Since PWAs are disproportionately male, black, and Hispanic, and these groups are more likely to be uninsured, PWAs probably pay out-of-pocket substantially more than 80 percent of the cost of outpatient drugs (26). The following subsections examine the cost of various outpatient drugs and alternative therapies.

AZT. Azidothymidine (also known as Retrovir and zidovudine) is the only antiviral drug approved for the treatment of AIDS. It costs about \$4,000 to \$7,000 per year depending on the dosage (1,27). Burroughs Wellcome recently cut the wholesale price of AZT from \$150 to \$120 for a 100-tablet bottle of 100-milligram tablets. Wholesale and retail markups raise the price to about \$160 a bottle, or \$1.60 a tablet. Available information suggests that the average patient on AZT takes about 700 milligrams, or 7 tablets, a day (a full dose is 1,200 milligrams a day) costing \$11.20. The cost for a patient who takes 700 milligrams a day of AZT for 12 months is \$4,000. Less than full dosages of AZT are taken to lessen the severity of side effects and enable more patients to use the drug. AZT is sometimes toxic to the bone marrow and often a blood transfusion is required.

Between April 1, 1987, and March 31, 1988, 35 percent of Medi-Cal beneficiaries with AIDS (865 of 2,471) had claims for AZT (14). In September 1988, a spokesperson for Burroughs Wellcome indicated in the Wall Street Journal that 25,000 people received AZT worldwide and that 6,000 of these people received AZT in a clinical trial (27). On July 27, 1989, Richard Teske, Director of Federal Government Relations for Burroughs Wellcome, indicated to me that it was reasonable to assume that 17,000 of the 19,000 people who purchased AZT in September 1988 resided in the United States, that 15,000 of these people are PWAs, and that the proportion of people using AZT has risen at about the same rate as the number of people alive with AIDS.

In September 1988, about 31,500 people had AIDS, resulting in an estimate that about 48 percent (15,000 of 31,500) had purchased AZT. As

of June 30, 1989, CDC data showed 41,922 people alive with AIDS. If it is assumed that the proportions remained stable, then almost 20,000 PWAs purchased AZT in June 1989. Combining the estimated \$4,000 annualized cost per patient using AZT with an estimate of 45 percent as the proportion of PWAs using AZT yields an annualized cost of \$1,800 for each PWA, or \$2,250 for the lifetime cost of a PWA, using a mean survival time of 15 months.

Aerosol pentamidine. Data from an August 1988 survey by AIDS Treatment News of its readers revealed that 27 percent of the 391 respondents designated aerosol pentamidine as one of the three best or three worst treatments for AIDS, HIV, or any related condition (28). Aerosol pentamidine was listed as one of the three best treatments by 165 respondents, and one of the worst treatments by 1 subscriber. The manufacturer of pentamidine (LyphoMed, Inc.) has stated that the sales of pentamidine are expected to increase \$15 million to \$20 million in 1989 as a result of recent FDA decisions (29).

Clinical studies at San Francisco General Hospital indicate that 1 year of aerosol pentamidine treatment costs \$2,100, including \$1,200 for the drug and \$900 for the inhalant equipment (29). An increase in sales of \$15 million to \$20 million translates into use by 12,500 to 16,666 patients, or 30 to 40 percent of the 41,922 PWAs alive as of June 30, 1989. This study uses 35 percent as an estimate of the proportion of PWAs who use aerosol pentamidine. Since the annualized cost per patient of aerosol pentamidine is \$2,100, the cost of aerosol pentamidine is \$735 ($\$2,100 \times .35$) per AIDS patient per year, and \$919 per AIDS patient for a 15-month period.

These are conservative estimates because the cost of aerosol pentamidine to patients at SFGH is probably less than to other patients and because FDA approval for the use of aerosol pentamidine for prophylaxis against PCP will increase its use. The Public Health Service in the June 16, 1989, Morbidity and Mortality Weekly Report recommended that physicians initiate prophylaxis against PCP using aerosol pentamidine for people infected with the AIDS virus who have T-4 cell counts less than 200, or T-4 cell counts less than 20 percent of total lymphocytes, or for people who have had PCP (30).

AL-721. AL-721 is a substance composed of fats occurring naturally in eggs and is available as a

food. It was developed in 1981 by Dr. Meier Shinitzky at the Weizmann Institute of Science in Rehovet, Israel (25). Some researchers hypothesize that AL-721 removes cholesterol from the membrane surrounding the HIV virus, making it more difficult for the virus to infect cells. Ethigen Corporation of California has the exclusive license to manufacture and distribute AL-721. However, a number of AL-721 substitutes are being used by PWAs, and the use of these substitutes makes it difficult to estimate the number of PWAs that drink some form of an egg-lecithin concoction each day.

According to a recent article in the periodical *AIDS Patient Care*, as many as 30 to 50 percent of people with AIDS are thought to be taking AL-721 or some generic version (31). About one-third of the respondents in the AIDS Treatment News survey (131 of 391) cited AL-721 as one of the three best or worst drugs they have used. If it is assumed that only those who cited it as one of the three best drugs still use AL-721, then 22 percent (85 of 391) of the respondents use AL-721. AL-721 costs about \$160 for 1 kilogram, which is a 50-day supply for a patient who takes 20 milligrams per day (24)—a cost of \$3.20 per day or \$1,168 per year. It is assumed that 22 percent of PWAs take AL-721 so that the annualized cost of AL-721 per PWA is \$257 ($\$1,168 \times .22$) and the cost per 15-month period is \$321 ($\$1,168 \times .22 \times 1.25$).

Dextran sulfate. Dextran sulfate is an anticholesterol and anticoagulant drug manufactured in Japan where it is sold over the counter. It is available from several buyers clubs at a cost of about \$280 for 1,000 tablets each containing 300 milligrams (24). The usual dose is a 300-milligram tablet taken nine times a day, and the cost is about \$75 a month or \$900 a year. About 16 percent of the respondents in the AIDS Treatment News survey (61 of 391) cite dextran sulfate as one of the three best treatments. Thus, assuming that the percentage of respondents who cited dextran sulfate as one of the three best treatments still use it, the annualized cost of dextran sulfate is equal to \$144 ($\$900 \times .16$), and the cost per PWA for a 15-month period is \$180 ($\$1,440 \times 1.25$).

Other drugs and therapies. There are a host of other drugs (for example, ganciclovir, alpha interferon, fluconazole, Foscarnet, ribavirin) and alternative therapies (acupuncture, mega-vitamins, herbal therapy) whose costs should be included in a

study of the medical care costs of AIDS. However, data on the number of AIDS patients using these drugs and therapies are poor, and little is known about dosage or duration of use. For AIDS patients who have health insurance policies that cover outpatient drugs, alpha interferon to treat Kaposi's sarcoma and ganciclovir to prevent blindness from cytomegalovirus retinitis probably are covered because of their recent approval by the FDA.

There is evidence that AIDS patients use alternative therapies. In a recent survey administered by the University of Illinois, 36 percent (18 of 50) of PWAs responding indicated that they used acupuncture, image therapy, mega-vitamins, or unapproved medications (32). A University of Miami School of Medicine study showed that 57 percent of seropositive patients consumed large doses of vitamin-mineral supplements (33). At present, there are few data on the proportion of AIDS patients who use these therapies or on the cost of these therapies. It is assumed in this paper that the annualized cost per AIDS patients of outpatient drugs (excluding AZT, aerosol pentamidine, AL-721, and dextran sulfate) and of alternative therapies is \$100 a month or \$1,200 a year. Thus, the cost per PWA for a 15-month period is assumed to be \$1,500.

Projected Number of AIDS Cases

In this section, the number of AIDS cases reported to CDC is projected for the 5 years from 1989 through 1993. The data set used is composed of the numbers of AIDS cases reported to CDC for 70 consecutive 4-week periods from January 1984 to June 1989.

Estimates are presented using two statistical models: a linear model in which the dependent variable is the square root of the number of cases and the independent variable is the time period (Model B) and a quadratic model in which the dependent variable is the number of cases and the independent variables are the time period and the square of the time period (Model A). A back-calculation model (Model C) also is employed. Back-calculation models use the relationship between the number of infected people, the distribution of incubation periods (that is, the rates of progression from infection to AIDS), and the number of people with AIDS, to project AIDS cases (34). This study uses the incubation period distribution derived by Bacchetti and Moss (35).

If the number of AIDS cases and the distribution of incubation periods are known, then the number

Table 3. Projected number of AIDS cases diagnosed each year, 1989 through 1993

| Model | 1989 | 1990 | 1991 | 1992 | 1993 |
|-------------------------------------------------------|--------|--------|--------|---------|--------|
| A (new quadratic) | 40,094 | 51,866 | 64,867 | 79,320 | 95,225 |
| B (new linear) | 39,810 | 51,180 | 63,981 | 78,232 | 93,867 |
| C (back-calculation Bacchetti-Moss progression) | 50,557 | 64,442 | 78,176 | 85,426 | 89,616 |
| D (CDC) | 49,000 | 60,000 | 71,000 | 80,000 | ... |
| E (old quadratic) | 47,905 | 64,985 | 84,887 | 107,615 | ... |
| F (old linear) | 40,912 | 52,767 | 66,131 | 80,998 | ... |

NOTE: CDC = Centers for Disease Control.

Table 4. Projected number of AIDS cases diagnosed each year, 1989 through 1993, adjusted upward for underreporting

| Model | 1989 | 1990 | 1991 | 1992 | 1993 |
|-------------------------------------------------------|--------|--------|--------|---------|---------|
| A (new quadratic) | 44,103 | 57,052 | 71,354 | 87,252 | 104,747 |
| B (new linear) | 43,791 | 56,298 | 70,379 | 86,055 | 103,254 |
| C (back-calculation Bacchetti-Moss progression) | 55,613 | 70,886 | 85,994 | 93,969 | 98,578 |
| D (CDC) | 49,000 | 60,000 | 71,000 | 80,000 | ... |
| E (old quadratic) | 52,695 | 71,483 | 93,376 | 118,376 | ... |
| F (old linear) | 49,139 | 58,044 | 72,743 | 89,098 | ... |

NOTE: CDC = Centers for Disease Control.

of people who must be infected to generate the observed AIDS cases may be calculated (this is referred to as "back calculation"). Using these estimates of the number of infected people and assuming a particular incubation period distribution, estimates of the number of people who will acquire AIDS from the pool of those currently infected may be calculated for several years into the future. In order to make reasonable estimates beyond 2 or 3 years, it is necessary to make some assumptions about the number of people who will become infected beyond the years for which current data may be used to "back calculate" the number of infected people.

Estimates derived using the back-calculation technique are sensitive to assumptions about the number of people who will become infected. In this study, it is assumed that 50,000 people will be infected each year between 1987 and 1993. If it had been assumed that 100,000 people would be infected during each of these years, then the estimates derived using the back-calculation technique would be higher than those using Models A and B during each of the years between 1989 and 1993.

Forecasts of the future number of AIDS cases derived from the two statistical extrapolation models are obtained by using the coefficients of the estimated polynomial and time period designations from 1989 through 1993. Projections of the num-

ber of reported AIDS cases are translated into projections of the number of AIDS cases to be diagnosed in the future by multiplying an estimate of the ratio of the number of diagnosed AIDS cases during a given year to the number of reported AIDS cases during the given year.

The ratio of the number of diagnosed AIDS cases to the number of reported AIDS cases is 1.30 for 1985, 1.33 for 1986, and 1.22 for 1987. These ratios are derived from HIV/AIDS Surveillance reports issued by CDC. However, the ratio of the number of diagnosed to reported AIDS cases has dropped over the past 18 months. As of August 1989, the ratio of diagnosed to reported AIDS cases for 1988 is .88. As of August 1988, the ratio for 1987 was 1.12. The same ratio for 1986 was 1.06 as of August 1987. The ratio of diagnosed to reported AIDS cases for 1987 (1.12) rose 10 percent to 1.22 between August 1988 and August 1989, while the ratio for 1987 (1.06) rose 25 percent to 1.33 between August 1987 and August 1989.

If we assume that the ratio of diagnosed to reported AIDS cases for 1988 will rise 17.5 percent (the average of 10 percent and 25 percent), then the ratio for 1988 eventually will be 1.034 (.88 × 1.175). In this paper, we translate projections of the number of reported AIDS cases into projections of the number of diagnosed AIDS cases by multiplying by 1.034. The recent fall in the ratio of

diagnosed to reported AIDS cases during a given year reflects the drop in the rate of increase in AIDS cases. If this trend continues, then our projections will overestimate the actual number of cases.

Estimates for the quadratic equation with the new data are

$$\text{Model A: } C_t = 192 + 15.92T + .3207^2$$

(1.79) (2.28) (3.35)

where C_t is the number of cases reported during the T th 4-week period, T is the number of the time period, and the values in the parentheses are the T -ratios of the coefficients above them. The square of the correlation coefficient is .88.

Estimates for the linear equation with the new data are

$$\text{Model B: } C_t^{1/2} = 14.0 + .561T$$

(16.6) (27.1)

The square of the correlation coefficient is .92.

Table 3 presents estimates of the number of AIDS cases that will be diagnosed from 1989 through 1993. Models A and B are estimated with data from January 1984 to June 1989 (new data). Models E and F are the same as Models A and B except they were derived using data for the period January 1984 to June 1988. The CDC estimates, D in table 3, are based on cases diagnosed between July 1983 and June 1987 and reported by March 1988 (36). The CDC estimates have been adjusted upward 19 percent by CDC to account for diseases not reportable under the pre-1987 definition and for AIDS cases never reported. Estimates derived from Models A and B are lower than estimates derived from Models D and E (table 3), because the rate of increase in reported AIDS cases slowed during the second half of 1988 and the first half of 1989.

In table 4 the data in table 3 are adjusted upward to account for underreporting. Estimates from Models A, B, D, and E were increased by 10 percent to reflect cases not reported to CDC. The CDC estimates in table 3 already have been increased to reflect cases not reported.

Projected Cumulative Costs and Conclusions

Scitovsky stated that the lifetime medical care costs of treating PWAs ranges between \$60,000 and \$90,000 (37). In this study, the best estimate of the lifetime medical care costs of treating a PWA is

\$75,009. This estimate is derived assuming that the average length of survival is 15 months and that the intensity of care does not diminish as survival time increases.

In a recent article, I estimated that the lifetime medical care costs for a PWA was about \$60,000 in 1988 dollars (1). The lifetime cost of treating a PWA will continue to increase if the average survival continues to lengthen and the use of expensive drugs such as AZT and aerosol pentamidine continues to spread. It is possible, however, that new drugs being tested at this time (for example, ddI or dideoxyinosine) will prove to be more effective and less expensive than drugs currently used.

The estimate employed in this study—that 30 percent of PWAs use aerosol pentamidine—was derived from an August 1988 survey, and it probably understates the proportion of PWAs currently using this aerosol. Aerosol pentamidine now is routinely provided to PWAs in Medicaid or a State-only program in Maryland unless there are specific contraindications (personal communication from Julia Hidalgo, PhD, Chief of the Center for AIDS Services Planning and Development, AIDS Administration, Maryland Department of Health and Mental Hygiene, August 17, 1989). The cost of using aerosol pentamidine will fall substantially if home use increases. Among Long Island, NY, AIDS patients, about 70 percent of the use of aerosol pentamidine already occurs at home (personal communication from John Haigney, Director, Client Services, Long Island Association of AIDS Care, August 23, 1989). There is concern, however, that the hand-held nebulizers in home use are not adequate, and at present, the vast majority of those who use aerosol pentamidine receive the drug at outpatient clinics or at physicians' offices (personal communication from Deborah Cotton, MD, Director for AIDS, Beth Israel Hospital, Boston, MA, August 23, 1989).

Other costs associated with the use of pentamidine were not included in the \$2,100 estimate used in this study. Concerns about the spread of tuberculosis during therapy have caused some sites to install equipment in treatment rooms to remove air quickly and infuse new air. At present, there is no information on the number of sites that are retrofitting their facilities or on the cost of this construction. There are also liability and workmen's compensation concerns because employees who provide aerosol pentamidine therapy may be at a higher risk of contracting tuberculosis.

Estimates from Models A and B indicate that the

Table 5. Cumulative projected costs for treating AIDS patients diagnosed each year 1989 through 1993, (billions of 1988 dollars using average survival time of 15 months)

| Model | 1989 | 1990 | 1991 | 1992 | 1993 |
|-------------------------------------------------------|---------|---------|---------|---------|---------|
| A (new quadratic) | \$3.308 | \$4.279 | \$5.352 | \$6.545 | \$7.857 |
| B (new linear)..... | 3.285 | 4.223 | 5.279 | 6.455 | 7.745 |
| C (back-calculation Bacchetti-Moss progression) | 4.171 | 5.317 | 6.450 | 7.048 | 7.394 |
| D (CDC)..... | 3.675 | 4.501 | 5.326 | 6.001 | ... |
| E (old quadratic) | 3.953 | 5.362 | 7.004 | 8.879 | ... |
| F (old linear)..... | 3.686 | 4.354 | 5.456 | 6.683 | ... |

NOTE: CDC = Centers for Disease Control.

cumulative cost of treating AIDS in 1991 will be about \$5.3 billion in 1988 dollars. In a previous study using data for the period January 1984 to June 1988, I forecast that AIDS costs in 1991 would total about \$6.0 billion in 1988 dollars (1). If we assume 9 percent inflation in the hospital sector per year—it was 9 percent during 1988 (23)—then the \$5.3 billion estimate of AIDS costs for 1991 derived in this study is equivalent to \$6.9 billion in 1991 dollars. This sum is less than the \$8.5 billion forecast for 1991, in 1991 dollars, made by Scitovsky and Rice several years ago (20). These two forecasts differ partly because Scitovsky and Rice made prevalence-based estimates (that is yearly cost estimates) and included the cost of treating PWAs diagnosed during previous years who receive care during the given year as well as the cost of PWAs diagnosed and treated during the given year. Estimates in this study are incidence-based and include the lifetime costs of treating PWAs diagnosed during the given year.

Table 5 presents estimates of the cumulative lifetime medical treatment costs of people diagnosed with AIDS from 1989 through 1993 assuming an average survival of 15 months. These calculations assume that the intensity of care is constant throughout the lifetime of a PWA. To the extent that the intensity of care is less for those who survive longer, the cost estimates for the 15-month and 18-month survival times are biased upward. Projecting the cost of treatment is hazardous because it is impossible to know how future scientific advances and changes in the epidemiology of AIDS will affect costs. It is evident that AIDS patients diagnosed today will live longer than AIDS patients diagnosed several years ago. Yet, it is unclear whether AIDS patients diagnosed today will consume health services at the same rate as patients who were diagnosed and treated a year or two ago when most of the data used in this study were collected. It is likely that the intensity of care will diminish as longevity increases; however, it is

unlikely that it will diminish sufficiently to prevent the lifetime cost of medical care from increasing.

There is some evidence that the intensity of care has fallen over the last few years. Medi-Cal expenditures for AIDS patients per month have fallen from an average of \$2,429 in fiscal year 1985-86 to \$1,986 for fiscal year 1987-88, and the average length of hospital stay for an AIDS patient fell from 13.09 days in fiscal year 1985-86 to 11.22 days in fiscal year 1987-88 (14). However, California is not representative of the nation. For instance, the average length of a hospital stay for an AIDS patient in New York State rose from 19.2 days in 1986 to 20 days in 1988 (13b). In addition, the enhanced availability of many outpatient drugs (such as aerosol pentamidine, ganciclovir) may increase the costs of care.

A recent study of 36 homosexual males in Los Angeles revealed that outpatient drugs accounted for more than \$13,000 of the \$24,000 that was spent for outpatient care during the year following the diagnosis of AIDS (38). The authors state that, "This figure is higher than anticipated and is due, we feel, to our more accurate assessment of drug costs (about half of the total), and to more complete reporting of outpatient physician visits, labs, mental health services, and home nursing care" (38a). Data on treatment costs in this study were obtained from patient interviews and providers' bills. Studies based on insurer and hospital records underestimate the cost of many outpatient services because a substantial portion of these costs are borne directly by the PWA.

An effective way to acquire information on the cost of medical services is to survey or interview PWAs. To date only the two small studies in San Francisco and Los Angeles cited previously have obtained information directly from PWAs ((38) and personal communication from Anne A. Scitovsky of May 18, 1989). All other cost studies of PWAs have obtained data from a single hospital, insurer, or HMO. Estimates of the costs of treat-

ment derived from a single data source underestimate the costs because they exclude those borne by other insurers, hospitals, and HMOs, as well as costs borne directly by PWAs. It is not uncommon for PWAs to lose jobs and employer-based health insurance and be forced to rely on Medicaid, general assistance, and personal savings. It also is not uncommon for PWAs to receive care at more than one location.

The National Center for Health Services Research and Health Care Technology Assessment, Public Health Service, has awarded a contract to examine the cost of providing medical and other services to a total of about 1,500 people with HIV-related illnesses from a variety of geographic locations; about half of the group will be people diagnosed with AIDS (39). The AIDS Cost and Service Utilization Survey (ACSUS) will collect data on all medical services consumed during an 18-month period, including medical services provided by volunteers and medical services whose costs are borne directly by the person with the HIV-related illness. Information on these costs and services will be obtained from patient interviews, medical records, provider bills, and insurers.

The median time after infection and before a person is diagnosed with AIDS now is estimated at about 10 years (35). Earlier estimates suggested that the median was between 6 and 8 years. The early use of medications to slow the progression towards AIDS may result in even longer periods between infection and the diagnosis of AIDS. The increased time from infection to a diagnosis of AIDS, and the greater use of medications such as AZT and aerosol pentamidine to forestall some of the more severe complications of HIV, may considerably increase the number of people infected with HIV who have not developed AIDS as well as the cost of providing medical services for these people.

The medical care costs of treating HIV-infected people without AIDS is not addressed in this study and, to date, little is known about the magnitude of these costs (37). Yet, the recent approval by the FDA of a New Drug Application (NDA) to use aerosol pentamidine as prophylaxis against PCP will increase the use of this drug by HIV-infected people. In addition, the success of clinical trials sponsored by the National Institute of Allergy and Infectious Diseases that tested AZT on people with T-cell counts below 500 will increase the use of this drug by all people infected with the virus (40-43). Patients in these clinical trials getting a low dose did just as well as those who received a high dose, and there was no difference between the incidence

or severity of side effects between these groups.

These developments could lead to a large rise in the cost of treating people infected with HIV. Data from the Multicenter AIDS Cohort Study indicate that 5 percent of the 1,666 homosexual men infected at enrollment during 1984 and 1985 had T-cell counts less than 200 and 42 percent had T-cell counts less than 500 (44). It is likely, however, that many infected people with a T-cell count in excess of 200 will receive aerosol pentamidine and that many people with HIV and a T-cell count in excess of 500 will receive AZT. If 600,000 of the estimated 1 to 1.5 million people infected with HIV spend \$3,000 per year for aerosol pentamidine and \$5,000 per year for AZT, then the cost of just these two drugs would be \$4.8 billion per year (\$1.8 billion + \$3.0 billion). Medical management, testing, and counseling costs could add another \$600 million (\$1,000 per year per person) for a total of \$5.4 billion (30,45).

The source of funds for this care is unclear. Insurance companies are often unwilling to pay for "off-label" uses of drugs (that is, uses not included in the NDA) for people with HIV-related illnesses, and outpatient drugs and counseling services are either not covered or are poorly covered (because there are high deductibles and coinsurance levels) in most health insurance plans (1,40). Furthermore, a significant proportion of PWAs are black, Hispanic, and unemployed, and are unlikely to possess health insurance (9,26).

Future studies should examine the cost of providing medical care to people with HIV-related illnesses and compare the cost and mix of services consumed by various patient groups (that is, IVDUs, homosexual and bisexual men, and children and women). It is uncertain how care varies among these groups. Furthermore, it is uncertain how lack of insurance affects patterns of treatment and, as the number of PWAs that are IVDUs rises, the proportion of PWAs without insurance will rise. Only by examining the relationship between source of payment and the types of medical services provided to different groups of people with HIV-related illnesses can health officials improve the organization, delivery, and efficiency of care and adequately plan to provide for the needs of all who will require medical services in the future.

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